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(54) **THREE-DIMENSIONAL IMAGE DISPLAY DEVICE AND DRIVING METHOD THEREOF**

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H04N 21/442	(2011.01)
H04N 21/81	(2011.01)
H04N 13/04	(2006.01)
G09G 3/00	(2006.01)
G09G 3/20	(2006.01)

(52) **U.S. Cl.**

CPC ***H04N 17/04*** (2013.01); ***G09G 3/003*** (2013.01); ***G09G 3/20*** (2013.01); ***H04N 13/0404*** (2013.01); ***H04N 13/0409*** (2013.01); ***H04N 13/0425*** (2013.01); ***H04N 13/0477*** (2013.01); ***H04N 21/42202*** (2013.01); ***H04N 21/44*** (2013.01); ***H04N 21/44218*** (2013.01); ***H04N 21/816*** (2013.01); *G09G 2320/0693* (2013.01)

(58) **Field of Classification Search**

USPC 345/419

See application file for complete search history.

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(57) **ABSTRACT**

Disclosed are a 3D image display device and a driving method thereof. The 3D image display device includes a panel, a barrier panel, an image collector, and a timing controller. The panel includes a plurality of left-eye pixels and right-eye pixels. The barrier panel is disposed at a front surface of the panel, and includes a light transmitting area and a light blocking area. The image collector collects images of an object. The timing controller sets and stores a view map with the images in a view map correction mode and, in a 3D viewing mode, determines which of a plurality of viewing zones for a 3D image the object is located in and generates a barrier control signal for driving the barrier panel according to the determined result.

21 Claims, 5 Drawing Sheets

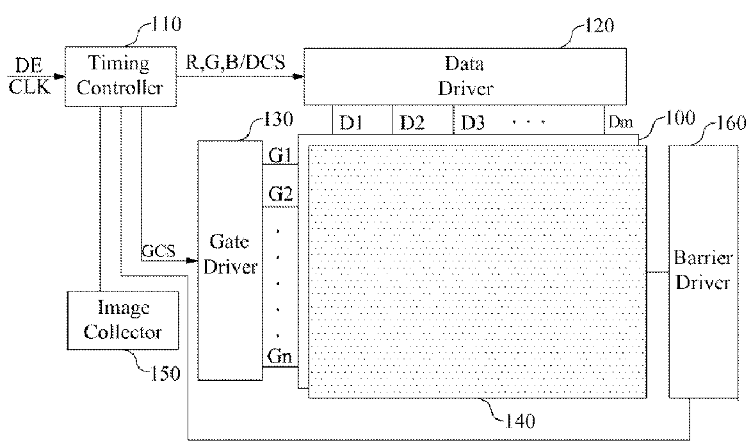

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FIG. 1

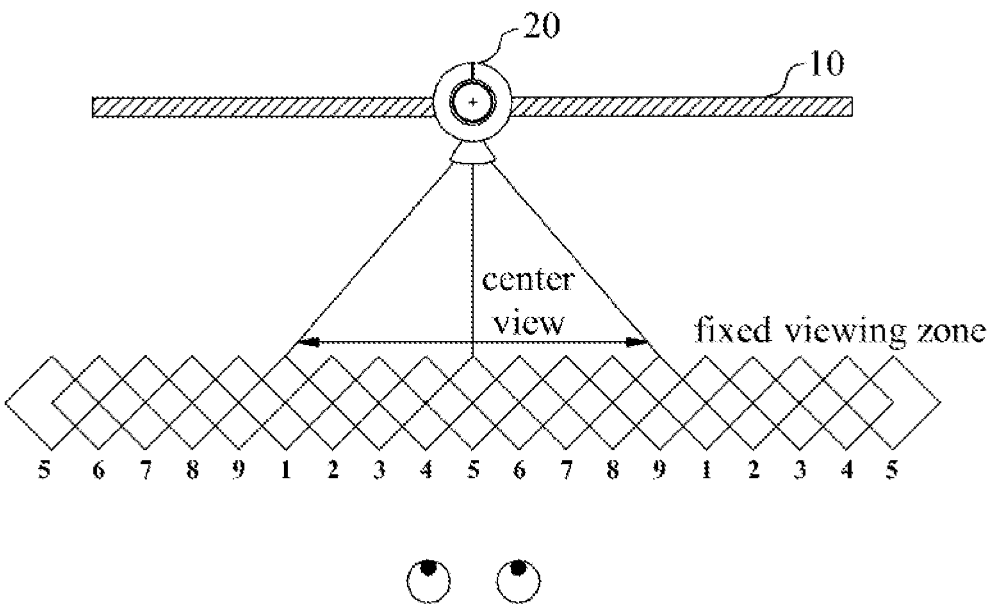


FIG. 2

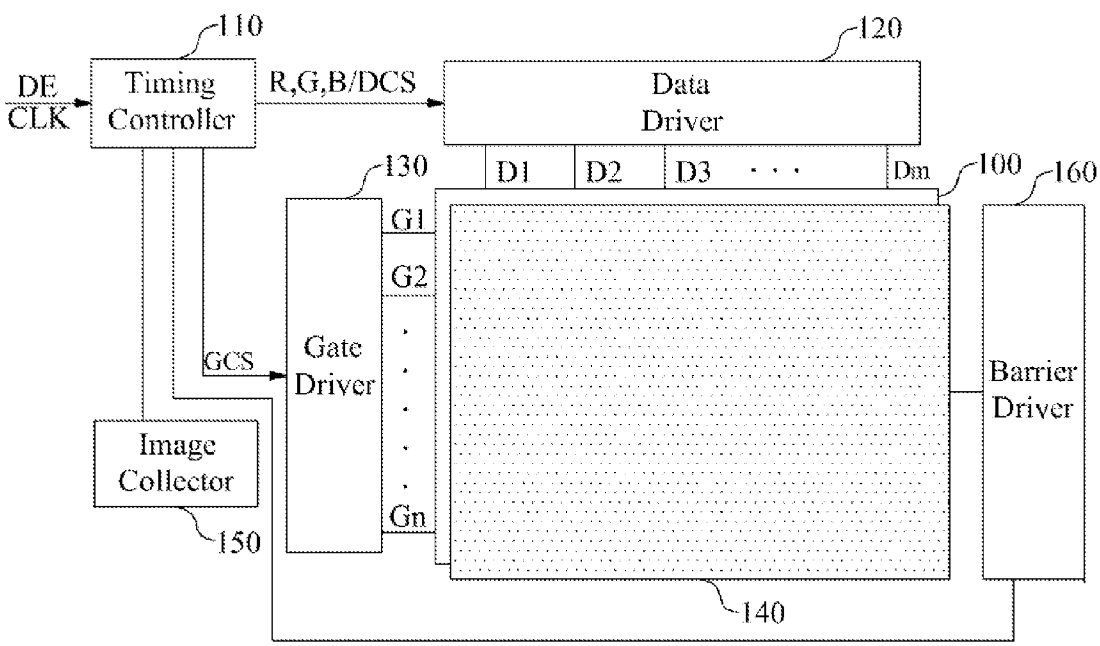

110
120
DE
CLK
Timing Controller
R,G,B/DCS
Data Driver
130
D1
D2
D3
Dm
100
160
G1
G2
GCS
Gate Driver
Barrier Driver
Image Collector
Gn
150
140

FIG. 3

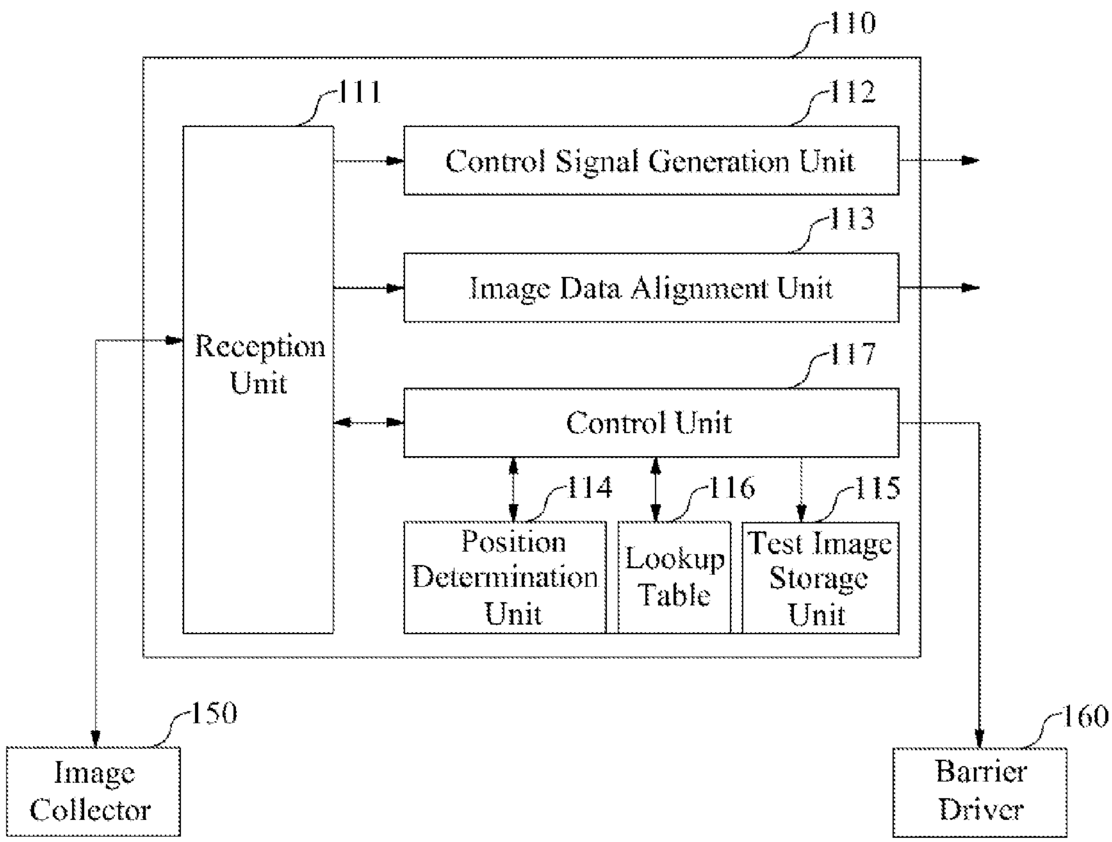

110
111
112
Control Signal Generation Unit
113
Image Data Alignment Unit
Reception Unit
117
Control Unit
114
116
115
Position Determination Unit
Lookup Table
Test Image Storage Unit
150
Image Collector
160
Barrier Driver

FIG. 4

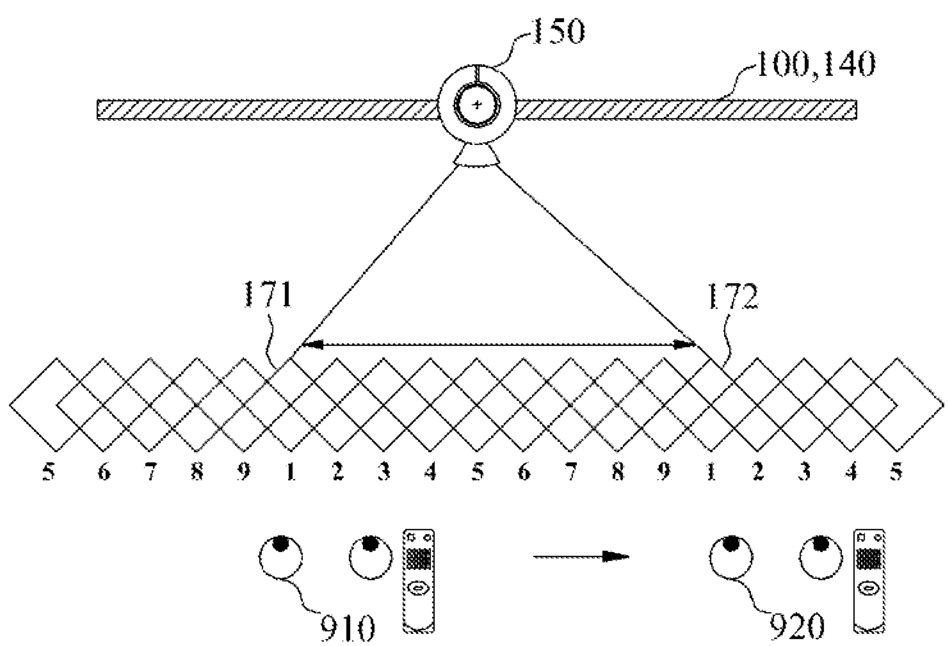
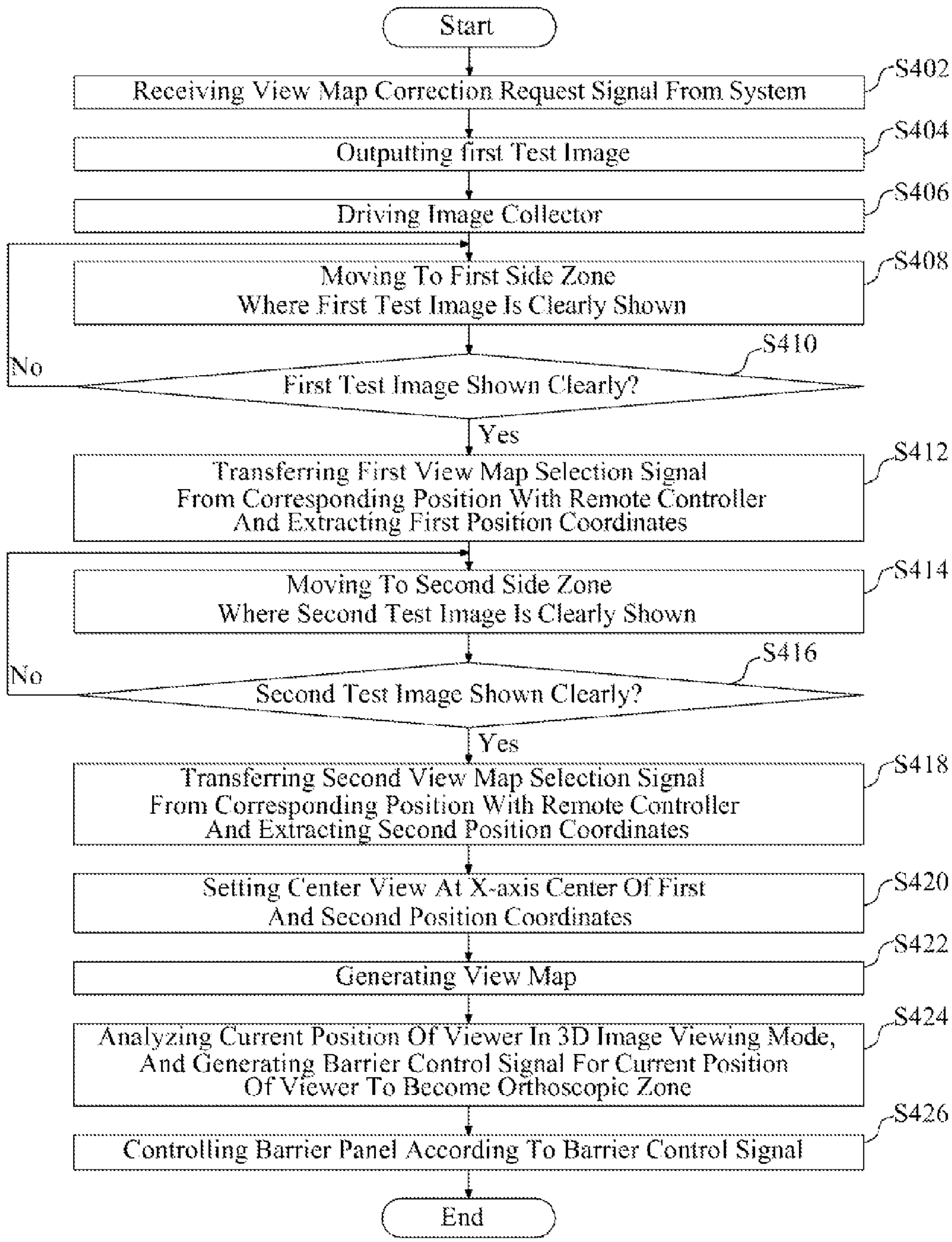


FIG. 5


Start
Receiving View Map Correction Request Signal From System
S402
Outputting first Test Image
S404
Driving Image Collector
S406
Moving To First Side Zone
Where First Test Image Is Clearly Shown
S408
First Test Image Shown Clearly?
S410
No
Yes
Transferring First View Map Selection Signal
From Corresponding Position With Remote Controller
And Extracting First Position Coordinates
S412
Moving To Second Side Zone
Where Second Test Image Is Clearly Shown
S414
Second Test Image Shown Clearly?
S416
No
Yes
Transferring Second View Map Selection Signal
From Corresponding Position With Remote Controller
And Extracting Second Position Coordinates
S418
Setting Center View At X-axis Center Of First
And Second Position Coordinates
S420
Generating View Map
S422
Analyzing Current Position Of Viewer In 3D Image Viewing Mode,
And Generating Barrier Control Signal For Current Position
Of Viewer To Become Orthoscopic Zone
S424
Controlling Barrier Panel According To Barrier Control Signal
S426
End

THREE-DIMENSIONAL IMAGE DISPLAY DEVICE AND DRIVING METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the Korean Patent Application No. 10-2011-0082358 filed on Aug. 18, 2011, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND

1. Field of the Invention

The present invention relates to a display device, and more particularly, to a Three-Dimensional (3D) image display device and a driving method thereof, which display an image three-dimensionally.

2. Discussion of the Related Art

3D image display devices three-dimensionally display an image with characteristic where perspective is given in combining different image signals discerned by two eyes.

Such a 3D image display technique is largely categorized into a stereoscopic technique, a volumetric technique, and a holographic technique.

Among these techniques, the stereoscopic technique is again categorized into a glasses technique and a glassesless technique. Recently, the glassesless technique is being actively researched.

The glassesless technique is again categorized into a lenticular lens technique and a parallax barrier technique using a parallax barrier.

Recently, as disclosed in Korea Patent Application No. 10-2008-0070497, a method is being developed where a display device tracks a viewer's motion through eye-tracking, and varies the image transmission effect of a barrier panel according to the tracked position of the viewer, thereby enabling the viewer to watch a 3D image from an orthoscopic zone even when moving from a current position to another position.

FIG. **1** is an exemplary diagram for describing a state where a related art 3D image display device is using an eye-tracking scheme.

In a related art 3D image display device **10**, a barrier panel including a parallax barrier or a lenticular lens is disposed in the front of a panel in a sheet type or the like, and thus respectively supplies different images to a user's left and right eyes to realize a 3D image.

FIG. **1** illustrates the 3D image display device **10** that displays a 3D image with nine views, and particularly illustrates a 3D image display device including a barrier panel where light transmission characteristic varies according to a voltage application scheme. Herein, for example, the barrier panel is configured with a liquid crystal electric field lens, and includes a switchable liquid crystal lens or a switchable barrier where a light transmitting direction varies according to the voltage application scheme.

The related art 3D image display device **10** of FIG. **1** tracks a viewer's position with an image collector **20** for eye-tracking, changes a voltage application scheme for the barrier panel to vary the light transmission characteristic of the barrier panel according to the tracked position of the viewer, and thus allows the tracked position to correspond to an orthoscopic zone, thereby enabling the viewer to view a normal 3D image.

Such an eye-tracking glassesless 3D image display device checks a view formed at the center thereof, thereby detecting a difference between a center point detected by the 3D image display device and a center point discerned by the viewer.

A method, which detects the difference between the center point detected by the 3D image display device and the center point discerned by the viewer, is performed through an operation where a measurer (manufacturer) directly measures the number of a corresponding view measured from the center point to check a view number in the center, namely, the number of center views, at a stage of manufacturing a 3D image display device.

A view map created by the method is predetermined as certain relative positions from the 3D image display device, in which case the position of the center view (being the center point) is also predetermined. Therefore, when a viewer actually watches 3D images displayed by the 3D image display device, the 3D image display device varies the light transmission characteristic of the barrier panel according to the viewer's position, by using the viewer's position coordinates tracked by the image collector and the view map predetermined through the operation. Accordingly, viewers can watch normal 3D images from an orthoscopic zone at any time.

SUMMARY

Accordingly, the present invention is directed to provide a 3D image display device and a driving method thereof that substantially obviate one or more problems due to limitations and disadvantages of the related art.

An aspect of the present invention is directed to provide a 3D image display device and a driving method thereof, which output two test images to receive two view selection signals and set a new view map by using coordinates of a position from which the two view selection signals are received and the number of views for a panel, in a view map correction mode, and control a barrier panel to switch the position of an orthoscopic zone by using a view map and position coordinates extracted from an image, in a 3D viewing mode.

Additional advantages and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided a 3D image display device including: a panel including a plurality of left-eye pixels and right-eye pixels; a barrier panel disposed at a front surface of the panel, and including a light transmitting area and a light blocking area for transmitting or blocking a left-eye image and a right-eye image which are respectively outputted from the left-eye pixel and the right-eye pixel; an image collector collecting images of an object; and a timing controller setting and storing a view map with the images in a view map correction mode and, in a 3D viewing mode, determining which of a plurality of viewing zones for a 3D image the object is located in and generating a barrier control signal for driving the barrier panel according to the determined result.

In another aspect of the present invention, there is provided a 3D image display device including: a panel including a plurality of left-eye pixels and right-eye pixels; a barrier panel disposed at a front surface of the panel, and including a light transmitting area and a light blocking area for transmitting or blocking a left-eye image and a right-eye image which are respectively outputted from the left-eye pixel and the right-eye pixel; an image collector collecting images of an object; an image data alignment unit realigning video data suitably for the panel to output image data, the video data being received from a system; a position determination unit extracting position coordinates of the object from the images; and a control unit outputting a test image to the panel, generating and storing a view map by using a plurality of view selection signals received from the system and the position coordinates of the object extracted by the position determination unit when the view selection signals are received from the system, in the view map correction mode and, in the 3D image viewing mode, determining which of a plurality of viewing zones for a 3D image current position coordinates of the object correspond to using the current position coordinates and the view map and generating the barrier control signal for driving the barrier panel according to the determined result.

In another aspect of the present invention, there is provided a driving method of a 3D image display device including: outputting a first test image, generated with a first view, onto a panel, receiving a first view selection signal from a system, and extracting first position coordinates of an object in the middle of receiving the first view selection signal, when a view map correction mode is selected; outputting a second test image, generated with the first view, onto a panel, receiving a second view selection signal from the system, and extracting second position coordinates of the object in the middle of receiving the second view selection signal, when the first view selection signal is received; generating a view map with the first and second position coordinates to store the view map, the view map including coordinates of a plurality of orthoscopic zones which are formed with a 3D image including at least two or more views; and controlling a barrier panel by using current position coordinates of the object and the view map such that the current position coordinates correspond to an orthoscopic zone, when a 3D image viewing mode is selected, the current position coordinates being extracted from images which are collected by an image collector.

It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention. In the drawings:

FIG. **1** is an exemplary diagram for describing a state where a related art 3D image display device is using an eye-tracking scheme;

FIG. **2** is an exemplary diagram illustrating a configuration of a 3D image display device according to an embodiment of the present invention;

FIG. **3** is an exemplary diagram illustrating an internal configuration of a timing controller of a 3D image display device, according to an embodiment of the present invention;

FIG. **4** is an exemplary diagram illustrating a viewing zone displayed as nine views for describing a driving method of a 3D image display device, according to an embodiment of the present invention; and

FIG. **5** is a flowchart illustrating a driving method of a 3D image display device, according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the exemplary embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings.

FIG. **2** is an exemplary diagram illustrating a configuration of a 3D image display device according to an embodiment of the present invention.

The 3D image display device according to an embodiment of the present invention enables a viewer (which is viewing a glassesless 3D image display device using eye-tracking) to directly set and store a view map that includes coordinates information on an orthoscopic zone and pseudoscopic zone of the 3D image display device.

For this end, as illustrated in FIG. **3**, the 3D image display device according to an embodiment of the present invention includes: a panel **100** where a plurality of left-eye pixels and right-eye pixels are formed; a barrier panel **140** that is disposed at a front surface of the panel **100**, and includes a light transmitting area and a light blocking area for transmitting or blocking a left-eye image and a right-eye image which are respectively outputted from a left-eye pixel and a right-eye pixel; an image collector **150** that collects images of an object through eye-tracking; a timing controller **110** that sets and stores a view map with the images collected by the image collector **150** in a view map correction mode and, in a 3D viewing mode, determines which of viewing zones for 3D images the object is located in using the images collected by the image collector **150** and generates a barrier control signal for driving the barrier panel **140** according to the determined result; a gate driver **130** that sequentially applies a scan pulse to a plurality of gate lines formed in the panel **100**; a data driver **120** that applies digital image data (RGB) signals to a plurality of data lines formed in the panel **100**, respectively; and a barrier driver **160** that drives the barrier panel **140** to switch between the orthoscopic zone and the pseudoscopic zone according to the control of the timing controller **110**.

The 3D image display device according to the present embodiment may be implemented as a flat panel display device such a Liquid Crystal Display (LCD), an Field Emission Display (FED), a Plasma Display Panel (PDP), Electroluminescence device (EL), or an Electrophoresis Display (EPD). However, for convenience of a description, the LCD will be described below as an example of the present invention.

The panel **100** may be implemented in various types according to the type of a display device. For example, the panel **100** may be a liquid crystal display panel, a plasma display panel, an organic light emitting display panel, or an electrophoresis display panel. Hereinafter, for convenience of a description, the liquid crystal display panel will be described as an example of the panel **100**.

A plurality of pixels for displaying red, green, and blue (RGB) are formed in the panel **100**. The pixels are divided into a plurality of left-eye pixels that display a left-eye image and a plurality of right-eye pixels that display a right-eye image, for displaying 3D images in operational connection with the barrier panel **140**.

The timing controller **110** receives a timing signal (including a data enable signal DE, a dot clock CLK, etc.) to generate a plurality of control signals DCS and GCS for respectively controlling the operation timings of the data driver **120** and the gate driver **130**.

The control signal GCS for controlling the gate driver **130** includes a gate start pulse (GSP), a gate shift clock (GSC), a gate output enable signal (GOE), and a shift direction control signal (DIR). The control signal DCS for controlling the data driver **120** includes a source sampling clock (SSC), a polarity control signal (POL), and a source output enable signal SOE).

In the view map correction mode, The timing controller **110** according to an embodiment of the present invention outputs a test image to the panel **100**, and generates and stores a view map by using a plurality of view selection signals received from a system and position coordinates that are extracted by a position determination unit (**114** in FIG. **3**) when the view selection signals are received. In the 3D image viewing mode, the timing controller **110** determines which of viewing zones for 3D images an object is located in using the view map and the current position coordinates and of the object, and generates the barrier control signal for driving the barrier panel **140** according to the determined result. The function of the timing controller **110** will be below described in detail with reference to FIG. **3**.

Hereinafter, as illustrated in FIG. **3**, the timing controller **110** will be described as including elements for realizing a driving method of the 3D image display device according to an embodiment of the present invention, but the present embodiment is not limited thereto. In addition to the timing controller **110**, a separate controller that includes a reception unit **111**, a position determination unit **114**, a lookup table **116**, a test image storage unit **115**, and a control unit **117** may realize the function of the present invention, and may be included in a 3D image display device. However, in the below description of the present invention, for convenience of a description, the timing controller **110** will be described as including the elements.

The data driver **120** includes a plurality of data drive Integrated Circuits (ICs), and latches digital image data RGB according to the control of the timing controller **110**. Furthermore, by converting the digital image data RGB into a plurality of analog positive/negative gamma compensation voltages, the data driver **120** generates a plurality of analog positive/negative pixel voltages and respectively supplies the pixel voltages to a plurality of data lines D**1** to Dm.

The gate driver **130** includes one or more gate drive ICs, and sequentially supplies a scan pulse (gate pulse) to a plurality of gate lines G**1** to Gn.

The barrier panel **140** includes the light transmitting area and the light blocking area for transmitting or blocking a left-eye image outputted from a left-eye pixel and a right-eye image outputted from a right-eye pixel. The barrier panel **140** switches between the light transmitting area and the light blocking area according to the application order of voltages from the barrier driver **160** or the levels of the voltages, thereby switching the position of the orthoscopic zone that enables the viewing of 3D images.

The barrier panel **140** may be variously configured using a liquid crystal electric field lens disclosed in Korea Patent Application No. 10-2008-0070497 and technologies that have been known to those skilled in the art.

The barrier panel **140**, for example, may be configured with the liquid crystal electric field lens or the like, and configured with a switchable liquid crystal lens or a switchable barrier where a light transmitting direction varies according to a voltage application method.

Various types of barrier panels that have been known to those skilled in the art may also be applied to the present invention. The feature of the present invention is not limited to the configuration itself of the barrier panel, and thus, a description on the barrier panel **140** will not be provided below.

The barrier driver **160**, as described above, drives the barrier panel **140** to switch between the light transmitting area and the light blocking area that are formed in the barrier panel **140**. The barrier driver **160** may be configured using technologies that have been known to those skilled in the art.

In the 3D image viewing mode, the barrier driver **160** applied to the present invention controls the barrier panel **140** according to a barrier control signal that is transferred from the timing controller **110**.

The image collector **150** is built in the 3D image display device according to the present embodiment. The image collector **150** collects images of an object (viewer) that is located at a distance from the 3D image display device, and transfers the collected images of the object (viewer) to the timing controller **110**.

That is, the image collector **150** collects images of a viewer (object) that is watching 3D images on the 3D image display device according to the present embodiment. The collected images are transferred to and analyzed by the timing controller **110**, and thus, the position coordinates of the viewer are extracted from the images.

A camera may be used as the image collector **150**, but the image collector **150** may use an infrared sensor that determines a position using infrared light.

FIG. **3** is an exemplary diagram illustrating an internal configuration of the timing controller of the 3D image display device, according to an embodiment of the present invention. FIG. **4** is an exemplary diagram illustrating a viewing zone displayed as nine views for describing the driving method of the 3D image display device, according to an embodiment of the present invention, and illustrates a viewing zone that is displayed with image data including the nine views.

Referring to FIG. **3**, the timing controller **110** applied to the present embodiment includes: a reception unit **111** that receives video data and various timing signals (DE, CLK, etc.) from a broadcasting system; a control signal generation unit **112** that generates a control signal with the timing signals transferred from the reception unit **111**, and outputs the control signal; an image data alignment unit **113** that realigns the video data, transferred from the reception unit **111**, to be suitable for the characteristic of the panel **100** and outputs the realigned image data; a position determination unit **114** that extracts the position coordinates of an object from the images collected by the image collector **150**; a control unit **117** that outputs a test image to the panel, and then generates and stores a view map by using a plurality of view selection signals received from the system and the position coordinates of the object extracted by the position determination unit **114** when the view selection signals are received from the system, in the view map correction mode, and determines which of viewing zones for 3D images the object is located in using the position coordinates of the object and the view map and generates the barrier control signal for driving the barrier panel **140** according to the determined result, in the 3D image viewing mode; a lookup table **116** that stores view maps; and a test image storage unit **115** that stores test images.

The reception unit **111**, as described above, receives the video data and the timing signal, transfers the timing signal to the control signal generation unit **112**, and transfers the video data to the image data alignment unit **113**.

The control signal generation unit **112**, as described above, generates the control signals GCS and DCS for respectively controlling the gate driver **130** and the data driver **120** with the timing signal transferred from the reception unit **111**.

The image data alignment unit **113** realigns the received video data to be suitable for the characteristic of the panel **100**, and transfers the aligned image data to the data driver **120**.

Moreover, the image data alignment unit **113** may transfer test images, which are transferred from the test image storage unit **115** through the control unit **117**, to the data driver **120**.

However, the control unit **117** may directly transfer the test images to the data driver **120**, in which case the image data alignment unit **113** may not transfer the image data to the data driver **120** according to an output stop control signal received from the control unit **117**.

The position determination unit **114** extracts the position coordinates of a viewer that is watching 3D images on the 3D image display device according to the present embodiment, by using images collected by the image collector **150**.

The following description will be made on a method where the position determination unit **114** determines the position coordinates of a viewer by using images collected by the image collector **150**.

By scanning the image collector **150** in a direction from the left to the right or from the right to the left of the 3D image display device, the position determination unit **114** or control unit **117** of the timing controller **110** may obtain width information (W_person, X coordinate) of an object (viewer) that is located in the front of the 3D image display device, and analyze the reflection time of infrared light to obtain distance information (D_person, Y coordinate) of the object (viewer).

Particularly, the position coordinates (X,Y) of an object (viewer) may be defined as expressed in Equation (1) below.

$$(X,Y)=\{(W1+W2)/2,D\_\text{person}\} \tag{1}$$

For the above-described determination, the image collector **150** may move in a left and right direction or an upward and downward direction by a driver (not shown). The position determination unit **114** or the control unit **117** may control the driver to control the position or angle of the image collector **150**, and thus, as described above, enable the image collector **150** to collect images through scanning.

When a camera is used as the image collector **150**, X coordinate may be determined by a face detecting scheme, and Y coordinate may be determined using disparity information of a stereo camera or depth information of a depth camera.

That is, when a camera is used as the image collector **150**, the position determination unit **114** may determine the X coordinate of a viewer in a scheme that detects the face of the viewer from images collected by the camera. Such a face detecting scheme may apply a general scheme, and thus, its detailed description is not provided.

Moreover, when a camera is used as the image collector **150**, a stereo camera or a depth camera is applied as the camera, and thus, the Y coordinate of an object (viewer) may be determined using information collected by the stereo camera or the depth camera.

The lookup table **116** stores a view map that is generated by the control unit **117**.

In the present embodiment, the view map denotes coordinates information of a viewing zone that enables the viewing of 3D images displayed on the 3D image display device. The viewing zone is divided into an orthoscopic zone, a pseudoscopic zone, and an invisible zone.

The orthoscopic zone is a zone that enables a viewer to normally watch 3D images, and denotes a zone where a right-eye image is transferred to the viewer's right eye and a left-eye image is transferred to the viewer's left eye.

In the pseudoscopic zone, since disparity information of an image is transferred, a viewer discerns images three-dimensionally. However, the pseudoscopic zone is a zone where a left-eye image is transferred to the viewer's right eye and a right-eye image is transferred to the viewer's left eye, and thus, the viewer's eyes feel fatigue more rapidly in the pseudoscopic zone.

The invisible zone is a zone that disables a viewer to watch the viewing of 3D images.

The view map includes coordinates information on positions where the three zones are displayed.

However, all zones other than the orthoscopic zone and pseudoscopic zone can be determined as the invisible zone, and thus, the view map may not include coordinates information on the invisible zone.

When the position coordinates of an object determined by the position determination unit **114** are not included in a coordinate zone corresponding to the orthoscopic zone or pseudoscopic zone where the position coordinates are included in a view map, the control unit **117** may determine a corresponding zone as the invisible zone.

As the number of views applied to the panel **100** increases, the orthoscopic zone, the pseudoscopic zone, and the invisible zone are more complicated and diversified.

That is, the control unit **117** cannot generate a view map by using only the position coordinates of images collected by the image collector **150**. The control unit **117** can generate a view map by integratedly using the number of views displayed on the panel **100**, the size of the panel **100**, the pitch of each pixel formed in the panel **100**, and the characteristic of the barrier panel **140**.

Accordingly, the lookup table **116** may store various information that the control unit **117** refers to for generating a view map, for example, may further store at least one of: the number of views displayed on the panel **100**; the size of the panel **100**; the pitch of each pixel formed in the panel **100**; and the characteristic of the barrier panel **140**.

The test image storage unit **115** stores test images that are displayed on the panel **100**, in the view map correction mode.

The test image may be a first test image that is viewed only in a first orthoscopic zone (one of orthoscopic zones included in the viewing zone) in a one side direction from the front center of the 3D image display device, and a second test image that is viewed only in the first orthoscopic zone (one of orthoscopic zones included in the viewing zone) in the other side direction from the front center.

As illustrated in FIG. **4**, when the 3D image display device of the present embodiment is assumed as displaying images with nine views, a first orthoscopic zone **171** formed by a first view is disposed within a distance leftward from a center direction a camera indicates, and a second orthoscopic zone **172** formed by the first view is disposed within a distance rightward from the center direction. Accordingly, the 3D image display device of the present embodiment stores and uses test images by using the first view that is shown in the first orthoscopic zone and the second orthoscopic zone.

Therefore, if the positions of the first and second orthoscopic zones formed by the first view are determined, the intermediate position of X coordinates of the first and second orthoscopic zones may be designated as the X coordinate of a center view.

Herein, as described above, the first and second test images are images, which are displayed on the panel **100** by the first view, among images displayed by first to nth views. The first and second test images may be the same type of images or different types of images.

However, when a viewer designates a first orthoscopic zone with the first test image and then switches a position for searching the second orthoscopic zone, the first and second test images may be outputted as different images for informing the viewer of a need for position switching for the search of the second orthoscopic zone.

For example, the first test image for the search of the first orthoscopic zone is displayed as 1, and the second test image for the search of the second orthoscopic zone is displayed as 2.

When a current mode is switched into the view map correction mode, the control unit **117** may display **1** that is the first test image for the search of the first orthoscopic zone. When a first view selection signal is received from a user side, the control unit **117** may display the second test image displayed as 2 for the search of the second orthoscopic zone.

In the view map correction mode, the control unit **117** sequentially outputs the first and second test images, stored in the test image storage unit **115**, to receive the first view selection signal and a second view selection signal, and calculates an intermediate position between the first and second orthoscopic zones as the position of the center view by using the position coordinates of a user (object) when the view selection signals are received. That is, the control unit **117** calculates the position coordinates of the center view with a ½ point of the X coordinates of the first and second orthoscopic zones as the X coordinate of the center view and with a ½ point of the Y coordinates of the first and second orthoscopic zones as the Y coordinate of the center view.

The control unit **117** generates the coordinates of a plurality of orthoscopic zones that are illustrated in FIG. **4**, by integratedly using the center view, the number of views displayed on the panel **100**, the size of the panel **100**, the pitch of each pixel formed in the panel **100**, and the characteristic of the barrier panel **140**. The control unit **117** generates a view map including coordinates information on orthoscopic, pseudoscopic, and invisible zones by using the generated coordinates, and stores the view map in the lookup table **116**.

When the view map is stored in the lookup table **116** in the view map correction mode and then a current mode is switched into the 3D image viewing mode, the control unit **117** determines which of orthoscopic, pseudoscopic, and invisible zones the current position coordinates of a viewer correspond to using the view map and the current position coordinates of the viewer collected by the image collector **150**.

When the determined result shows that the current position coordinates correspond to the orthoscopic zone, the control unit **117** analyzes the view map and the current position coordinates of the viewer to generate a barrier control signal that allows the current position coordinates of the viewer to correspond to the orthoscopic zone, and transfers the barrier control signal to the barrier driver **160**.

In the 3D image viewing mode, the control unit **117** controls the barrier driver **160** such that the current position coordinates of a user always correspond to an orhtoscopic zone.

Hereinafter, a driving method of the 3D image display device according to an embodiment of the present invention will be described in detail with reference to FIGS. **3** to **5**.

FIG. **5** is a flowchart illustrating a driving method of the 3D image display device, according to an embodiment of the present invention.

Left and right images, namely, images of two views are required to be respectively transferred to a left eye and a right eye so as to enable a viewer to recognize an image, outputted from the 3D image display device, as a 3D image. However, in glasseless 3D image display devices using no special 3D image glasses, a zone enabling the viewing of 3D images is limited to a light path, and thus, image contents composed of a plurality of views are required for expanding a viewing zone.

As the number of views increases, a zone enabling the viewing of 3D images is expanded. The number of views is predetermined by a manufacturer for the 3D image display device. Hereinafter, as illustrated in FIG. **4**, a case where the 3D image display device of the present embodiment uses nine views will be described as an example of the present invention.

A viewing zone is relevant to the position of a viewer that is watching 3D images, and may be divided into the following three kinds of zones.

A first viewing zone is a position suitable for the viewer watching 3D images, and is an orthoscopic zone where a left-eye image is transferred to the viewer's left eye and a right-eye image is transferred to the viewer's right eye.

A second viewing zone is a position where the viewer feels three-dimensionality but cannot watch 3D images, and is a pseudoscopic zone where the right-eye image is transferred to the viewer's left eye and the left-eye image is transferred to the viewer's right eye.

A third viewing zone is a position that disables the viewer to watch 3D images, and is an invisible zone where combined left and right images are transferred to eyes or the viewer cannot watch 3D images itself.

To watch 3D images displayed on the 3D image display device, the viewer is required to be located in the orthoscopic zone where 3D images are accurately realized.

However, it is not easy for a viewer to accurately find the orthoscopic zone. Therefore, the 3D image display device of the present embodiment includes a function of automatically switching between the light transmitting area and the light blocking area of the barrier panel **140**, in order for the viewer's position to become the orthoscopic zone always. Particularly, in order for the switching to be performed more accurately, the 3D image display device of the present embodiment allows a viewer to directly set a view map that includes information of a reference point (position coordinates of a center view, etc.) for the switching.

For this end, the driving method of the 3D image display device according to the present embodiment may be greatly performed in four stages as follows.

A first stage includes operations S**402** to S**412** where when the view map correction mode is selected, the first test image generated with the first view is outputted by the panel **100**, the first view selection signal is received from the system, and first position coordinates of an object are extracted in the middle of receiving the first view selection signal.

A second stage includes operations S**414** to S**418** where when the first view selection signal is received, the second test image generated with the first view is outputted by the panel **100**, the second view selection signal is received from the system, and second position coordinates of an object are extracted in the middle of receiving the second view selection signal.

A third stage includes operations S**420** and S**422** that generate and store a view map having the coordinates of orthoscopic zones which are formed according to a 3D image having at least two or more views, by using first and second position coordinates.

A fourth stage includes operations S**424** and S**426** where when the 3D image viewing mode is selected, the barrier panel **140** is controlled in order for the current position coordinates of the object to correspond to an orthoscopic zone, by using the current position coordinates of the object collected and extracted by the image collector **150** and the view map generated through the operations.

Hereinafter, the above-described four stages of the present embodiment will be described in detail with reference to FIGS. **3** to **5**.

First, in the detailed operations of the first stage, the control unit **117** of the timing controller **110** receives a view map correction request signal from the system in operation S**402**.

The view map correction request signal is initially received when the 3D image display according to the present embodiment has been turned on, when a 3D image is being outputted, or when a Two-Dimensional (2D) image is being outputted.

That is, a viewer that is watching images displayed on the 3D image display device of the present embodiment may select a view map correction request menu that is disposed at a case of the 3D image display device or a remote controller. In this case, the view map correction request signal is received through the system by the control unit **117** that is included in the timing controller **110** or a separate device for implementing the driving method of the 3D image display device according to the present embodiment.

At this point, the control unit **117** outputs the first test image, stored in the test image storage unit **115**, through the first test image in operation S**404**.

Herein, the first test image is generated with the first view of two or more views that are used by the 3D image display device according to the present embodiment.

That is, at least two or more views are required for displaying a 3D image. Information corresponding to each pixel is extracted from the two or more views, thereby generating one screen that is displayed during one frame. For example, the 3D image display device of the present embodiment uses the first test image that is generated with the first view, and moreover uses the second test image that is generated with the first view.

The reason, as illustrated in FIG. **4**, is because the center view is disposed at an intermediate position between first orthoscopic zones (which are formed with the first view) with respect to right and left sides from the center of the panel **100**, in forming the viewing zone of the 3D image display device. Therefore, when the center view is disposed at an intermediate position between orthoscopic zones which are formed with an nth view, the first and second test images may be generated with the nth view.

While the first test image is outputted by the panel **100**, the control unit **117** disallows the image data alignment unit **113** to output video data (transferred from the system) to the data driver **120**.

In the view map correction mode, the output of the test image is required, and thus, the control unit **117** may stop the driving of the image data alignment unit **113**, transfer the test image directly to the data driver **120** or block video data inputted from the system to the image data alignment unit **113**, and transfer the test image to the image data alignment unit **113**, thereby allowing the test image from the image data alignment unit **113** to the data driver **120**.

While the first test image is outputted, the control unit **117** drives the image collector **150** and thus allows the image collector **150** to collect images of the object in operation S**406**.

When the view map correction request signal is generated by a viewer side (being a remote controller or the like) and then the first test image is outputted by the panel **100**, the viewer moves from a position (which is determined as the approximate center position of the 3D image display device) to a first side direction **910** (for example, a left direction in FIG. **4**) in operation S**408**, and simultaneously determines whether the first test image is clearly shown in operation S**410**.

The viewer side transfers the first view map selection signal from a position (where the first test image is determined as clearly being shown) to the 3D image display device by using the first view map selection menu included in a remote controller or the like in operation S**412**. When the first view map selection signal is received, the control unit **117** stores the current position coordinates of the viewer side, extracted by the position determination unit **114**, as first position coordinates.

In detailed operations of the second stage, when the first view selection signal is selected through the above-described operations, the control unit **117** outputs the second test image (which is generated with the first view) onto the panel **100**, at which point the viewer moves to a second side direction **920** (for example, a right direction in FIG. **4**) that is a direction opposite to the first side direction in operation S**414** and simultaneously determines whether the second test image is clearly shown in operation S**416**.

The viewer side transfers the first view map selection signal from a position (where the second test image is determined as clearly being shown) to the 3D image display device by using a second view map selection menu included in the remote controller or the like in operation S**418**. When the second view map selection signal is received, the control unit **117** stores the current position coordinates of the viewer side, extracted by the position determination unit **114**, as second position coordinates.

In detailed operations of the third stage, the control unit **117** extracts the X coordinate of the center view that is generated with a 3D image outputted from the 3D image display device, by using the first and second position coordinates that have been extracted through the above-described operations in operation S**420**.

When the image collector **150** is configured with an infrared sensor, an operation where the control unit **117** extracts the X coordinate of the center view may use the X-axis coordinate of the first position coordinates and the X-axis coordinate of the second position coordinates that are calculated by scanning the infrared sensor in a predetermined direction. Alternatively, when the image collector **150** is configured with a camera, the operation may use the X-axis coordinate of the first position coordinates and the X-axis coordinate of the second position coordinates that are calculated by the face detecting scheme.

In this case, the control unit **117** extracts the Y coordinate of the center view from images collected by the image collector **150**. Herein, when the image collector **150** is configured with an infrared sensor, an operation where the control unit **117** extracts the Y-axis coordinate of the center view may use the Y-axis coordinate of the object that is calculated by analyzing the reflection time of infrared light outputted from the infrared sensor, or when the image collector **150** is configured with a camera, the operation may use the Y-axis coordinate of the object that is calculated with disparity information or depth information that is supplied by the camera.

That is, the center view denotes the position views of the center portion of the viewing zone of the 3D image display device, and becomes a reference point for the control unit **117** determining an orthoscopic zone. Therefore, the control unit **117** extracts the position coordinates of the center view through the above-described operations, thereby setting a determination reference for all orthoscopic zones.

Therefore, when the position coordinates of the center view are extracted through the above-described operations, the control unit **117** generates a view map including the coordinates of orthoscopic zones that are formed by the 3D image display device of the present embodiment, by using the position coordinates of the center view and at least one of: the number of views displayed on the panel **100**; the size of the panel **100**; the pitch of each pixel formed in the panel **100**; and the characteristic of the barrier panel **140**, and stores the view map in the lookup table **116** in operation S**422**.

The view map is generated by integratedly using the various information, with the center view as the reference point. The view map includes coordinates information on orthoscopic zones and pseudoscopic zones.

To provide an additional description, the view map includes the position coordinates of orthoscopic zones or pseudoscopic zones that are illustrated in FIG. **4**.

When the generation of the view map that is used as reference information for determining an orthoscopic zone is completed through the above-described operations, a viewer can always watch 3D images, displayed on the 3D image display device of the present embodiment, from the orthoscopsic zone through the below-described final stage.

In detailed operations of the fourth stage, when the 3D image viewing mode is selected with a button that is disposed at an outer side of a remote controller of the 3D image display device, the control unit **117** drives the image data alignment unit **113** normally, and thus allows 3D images to be normally outputted with video data received from the system and extracts the current position coordinates of the object from images collected by the image collector **150** in operation S**424**.

At this point, the control unit **117** compares the extracted current position coordinates with the generated view map to determine whether the current position coordinates correspond to an orthoscopic zone. When the determined result shows that the current position coordinates do not correspond to the orthoscopic zone, the control unit **117** calculates the amount of change in the light transmitting area and light blocking area of the barrier panel **140** that allows the current position coordinates to correspond to the orthoscopic zone.

The control unit **117** generates the barrier control signal for controlling the barrier panel **140** according to the calculated amount of change, and transfers the barrier control signal to the barrier driver **160**.

When current position coordinates do not correspond to an orthoscopic zone, the 3D image display device automatically controls the light transmitting area and light blocking area of the barrier panel **140**, thereby allowing the current position coordinates to correspond to the orthoscopic zone. For this end, the 3D image display device compares the current position coordinates with the view map to approximately determine which position the current position coordinates correspond to.

When the determine result shows that a current position is not the orthoscopic zone, the control unit **117** determines an error between the current position coordinates and an orthoscopic zone with the view map, calculates the application scheme, application order, or levels of voltages (which will be applied to the barrier panel **140**) for reducing the error, generates the barrier control signal on the basis of the calculated information, and transfers the barrier control signal to the barrier driver **160**.

The barrier panel **140** switches the light transmitting area that transmits light outputted from the panel **100** and the light blocking area that blocks the light according to the application scheme, application order, or levels of voltages, thereby changing the position coordinates of an orthoscopic zone or the like. The control unit **117** generates the barrier control signal for switching the light transmitting area and the light blocking area, and transfers the barrier control signal to the barrier driver **160**.

The barrier driver **160** receiving the barrier control signal changes the application scheme, application order, or levels of voltages (which will be applied to the barrier panel **140**) to switch the light transmitting area and the light blocking area according to the barrier control signal, and thus allows the current position coordinates of the viewer to correspond to the orthoscopic zone in operation S**426**.

Various techniques that are used for switching the light transmitting area and the light blocking area may be applied to the barrier control signal, in a switchable barrier technique or a switchable liquid crystal lens technique.

A summary on the features of the present invention will now be described.

According to the present invention, in the eye-tracking glassesless 3D image display device, a viewer directly generates and uses the position coordinates of a center view that is used as reference information for determining an orthoscopic zone.

In the 3D image display device of the related art, a manufacturer directly measures various view numbers in a viewing zone, and directly checks and stores a center view number, namely, the number of center views and position coordinates.

On the contrary, in the present invention, a viewer that watches the eye-tracking glassesless 3D image display device can simply and directly check (calibrate) a center view that is formed at the center of the 3D image display device, and thus reduce an error of the center view that occurs between when manufacturing the 3D image display device and when viewing 3D images displayed on the 3D image display device, thereby enabling the viewer to watch the 3D images from a more accurate orthoscopic zone.

For this end, the 3D image display device of the present invention outputs an arbitrary pattern (first test image generated with a first view) that is clearly shown when a viewer is accurately located at the position of a 1view (left-eye 1view or right-eye 3view in FIG. **4**) (in which case an orthoscopic zone is referred to as a first orthoscopic zone).

The viewer transmits a signal (first view selection signal) from a pattern-checked position to a system by using a remote controller, moves to the position of a 2view (second orthoscopic zone), and again transmits a signal (second view selection signal) from the moved position to the system by using the remote controller, whereupon the system determines the position of a center view and the width of a single viewing zone.

By dividing the length of the width by the number of views (nine in FIG. **4**) that are used in the panel **100**, the width and position of one view may be obtained.

The control unit **117** generates a view map suitable of the viewer and a viewing environment, on the basis of the obtained information.

To provide an additional description, in the eye-tracking glassesless 3D image display device, when the view map correction mode is executed, the panel **100** outputs a position check pattern (first test image). The pattern (first test image) is clearly shown when a viewer is in the position of a 2view accurately. The viewer transmits a specific flag signal (first view selection signal) to the system by using a remote controller.

Subsequently, the viewer moves in a right direction and again finds a position where the pattern (second test image) is clearly shown, and then transmits the same flag signal (second view selection signal) to the system by using the remote controller.

Then, the control unit **117** checks the width of a view map the viewer recognizes and, by dividing the length of the width by the number of views, determines the width of each view the viewer recognizes actually. Therefore, the position of the center view is automatically corrected.

That is, the 3D image display device of the present invention sets two reference points (first and second orthoscopic zones) with respect to the position of a viewer by using the position check pattern (first and second test images), and automatically generates the view map.

Subsequently, in the 3D image viewing mode, the control unit **117** determines whether the current position coordinates of the viewer (extracted by the image collector **150**) correspond to an orthoscopic zone by using the view map, and when the current position coordinates do not correspond to the orthoscopic zone, the control unit **117** controls the barrier panel **140** such that the current position coordinates correspond to the orthoscopic zone.

According to the embodiments of the present invention, the 3D image display device outputs two test images to receive two view selection signals and sets a new view map by using the coordinates of a position from which the two view selection signals are received and the number of views for the panel, in the view map correction mode, and controls the barrier panel to switch the position of the orthoscopic zone by using the view map and position coordinates extracted from an image, in the 3D viewing mode, thus enhancing the viewing environment and image quality of glassesless 3D image display devices.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A Three-Dimensional (3D) image display device, comprising:
- a panel comprising a plurality of left-eye pixels and right-eye pixels;
- a barrier panel disposed at a front surface of the panel, and comprising a light transmitting area and a light blocking area for transmitting or blocking a left-eye image and a right-eye image which are respectively outputted from the left-eye pixel and the right-eye pixel;
- an image collector collecting images of a user; and
- a controller setting and storing a view map with the images of the user in a view map correction mode that is selected by the user,
- wherein in a 3D viewing mode, the controller determines which of a plurality of viewing zones for a 3D image current position coordinates of the user correspond to using the view map set and stored in the view map correction mode that is selected by the user and the current position coordinates extracted by using the images collected by the image collector, and
- when a determined result shows that the current position coordinates do not correspond to an orthoscopic zone that is a comfortable zone for viewing the 3D image, the controller adjusts the barrier panel so that the current position coordinates correspond to the orthoscopic zone without a change in a physical position of the user.

2. The 3D image display device of claim **1**, wherein when a view map correction request signal is received, the controller is switched to the view map correction mode, outputs a first test image viewable from a first orthoscopic zone to receive a first view selection signal, outputs a second test image viewable from a second orthoscopic zone to receive a second view selection signal, sets the view map with position coordinates from which the first and second view selection signals are received, and stores the view map.

3. A Three-Dimensional (3D) image display device, comprising:
- a panel comprising a plurality of left-eye pixels and right-eye pixels;
- a barrier panel disposed at a front surface of the panel, and comprising a light transmitting area and a light blocking area for transmitting or blocking a left-eye image and a right-eye image which are respectively outputted from the left-eye pixel and the right-eye pixel;
- an image collector collecting images of a user;
- an image data alignment unit realigning video data suitably for the panel to output image data, the video data being received from a system;
- a position determination unit extracting position coordinates of the user from the images of the user, the images of the user being collected by the image collector; and
- a control unit outputting a test image to the panel, generating and storing a view map by using a plurality of view selection signals received from the system and the position coordinates of the user extracted by the position determination unit when the view selection signals are received from the system, in a view map correction mode that is selected by the user,
- wherein in a 3D image viewing mode, the control unit determines which of a plurality of viewing zones for a 3D image current position coordinates of the user correspond to using the current position coordinates extracted by using the images collected by the image collector and the view map set and stored in the view map correction mode that is selected by the user, and
- when a determined result shows that the current position coordinates do not correspond to an orthoscopic zone that is a comfortable zone for viewing the 3D image, the controller adjusts the barrier panel so that the current position coordinates correspond to the orthoscopic zone without a change in a physical position of the user.

4. The 3D image display device of claim **3**, wherein in the view map correction mode,
- when a first test image viewable from a first orthoscopic viewing zone is transferred to the panel and then a first view selection signal is received from the system, the control unit temporarily stores the position coordinates, being coordinates at a time when the first view selection signal is received, as first position coordinates,
- when the first view selection signals is received, the control unit transfers a second test image to the panel, and then when a second view selection signal is received from the system, the control unit temporarily stores the position coordinates, being coordinates at a time when the second view selection signal is received, as second position coordinates, and
- the control unit generates the view map with the first and second position coordinates.

5. The 3D image display device of claim **4**, wherein when a view displayed by the panel comprises first to nth views, the first test image is a first image which is viewable from a first orthoscopic zone in one side direction with respect to a center coordinate, being a reference coordinate among X coordinates of the images collected by the image collector, and

the second test image is a second image which is viewable from a first orthoscopic zone in the other side direction with respect to the center coordinate.

6. The 3D image display device of claim **5**, wherein the first and second test images are the same type of images or different types of images.

7. The 3D image display device of claim **5**, wherein the first and second test images are images, which are displayed on the panel with the first view, among a plurality of images displayed with the first to nth views.

8. The 3D image display device of claim **6**, wherein the control unit calculates coordinates information of a plurality of orthoscopic zones which are formed between the first and second position coordinates by using the first and second position coordinates and the number of views, and generates the view map with the coordinates information.

9. The 3D image display device of claim **8**, wherein the view map comprises: coordinates information of a plurality of pseudoscopic zones which are formed between the first and second position coordinates; and coordinates information of a plurality of orthoscopic zones and pseudoscopic zones which are formed outside the first and second position coordinates.

10. The 3D image display device of claim **9**, further comprising:

a lookup table storing the view map; and

a test image storage unit storing the first and second test images.

11. The 3D image display device of claim **10**, wherein,

the lookup table stores information on at least one of: the number of views displayed on the panel, a size of the panel, a pitch of each pixel formed in the panel, and characteristic of the barrier panel, and

the control unit uses the information integratedly when generating the view map.

12. The 3D image display device of claim **3**, wherein when the image collector is configured with an infrared sensor, the position determination unit scans the infrared sensor in a predetermined direction to calculate an X coordinate of the user, and analyzes a reflection time of infrared light outputted from the infrared sensor to calculate a Y coordinate of the user, thereby extracting the position coordinates.

13. The 3D image display device of claim **3**, wherein when the image collector is configured with a camera, the position determination unit calculates an X coordinate of the user in a face detecting scheme, and calculates a Y coordinate of the user on the basis of disparity information or depth information which are supplied from the camera, thereby extracting the position coordinates.

14. The 3D image display device of claim **3**, further comprising a barrier driver receiving the barrier control signal to drive the barrier panel,

wherein the barrier driver changes an application scheme, application order, or levels of a plurality of voltages applied to the barrier panel to switch the light transmitting area and the light blocking area, according to the barrier control signal.

15. A driving method of a Three-Dimensional (3D) image display device, the driving method comprising:

outputting a first test image, generated with a first view, onto a panel, receiving a first view selection signal from a system, and extracting first position coordinates of a user in the middle of receiving the first view selection signal, when a view map correction mode is selected by the user;

outputting a second test image, generated with the first view, onto a panel, receiving a second view selection signal from the system, and extracting second position coordinates of the user in the middle of receiving the second view selection signal, when the first view selection signal is received;

generating a view map with the first and second position coordinates to store the view map, the view map comprising coordinates of a plurality of orthoscopic zones which are formed with a 3D image comprising at least two or more views;

determining whether a current position coordinates correspond to an orthoscopic zone by using the current position coordinates of the user and the view map set and stored in the view map correction mode that is selected by the user, when a 3D image viewing mode is selected; and

in the 3D image viewing mode, when a determined result shows that the current position coordinates do not correspond to an orthoscopic zone that is a comfortable zone for viewing the 3D image, controlling a barrier panel so that the current position coordinates correspond to the orthoscopic zone without a change in a physical position of the user,

wherein the current position coordinates is extracted from images which are collected by an image collector.

16. The driving method of claim **15**, wherein the receiving of the first view selection signal comprises:

receiving a view map correction request signal from the system;

outputting the first test image onto the panel, the first test image being generated with a first view of the at least two or more views;

driving the image collector to collect images of an object the user; and

extracting the first position coordinates from the collected images, when the first view map selection signal is received from the system.

17. The driving method of claim **15**, wherein the receiving of the second view selection signal comprises:

outputting the second test image onto the panel when the first view selection signal is received, the second test image being generated with the first view; and

extracting the second position coordinates from the collected images, when the second view map selection signal is received from the system.

18. The driving method of claim **15**, wherein the generating of the view map comprises:

extracting an X coordinate of a center view with the first and second position coordinates, the center view being generated with 3D image;

extracting a Y coordinate of the center view from the images collected by the image collector; and

generating and storing the view map by using the coordinates of the center view and at least one of: the number of views; a size of the panel; a pitch of each pixel formed in the panel; and characteristic of the barrier panel, the view map comprising coordinates of a plurality of orthoscopic zones which are formed with the 3D image.

19. The driving method of claim **18**, wherein,

when the image collector is configured with an infrared sensor, the extracting of X coordinate uses an X-axis coordinate of the first position coordinates and an X-axis coordinate of the second position coordinates which are calculated by scanning the infrared sensor, and

when the image collector is configured with a camera, the extracting of X coordinate uses an X-axis coordinate of the first position coordinates and an X-axis coordinate of the second position coordinates which are extracted by a face detecting scheme.

20. The driving method of claim **18**, wherein,

when the image collector is configured with an infrared sensor, the extracting of Y coordinate uses a Y-axis coordinate of the user which is calculated by analyzing a reflection time of infrared light outputted from the infrared sensor, and

when the image collector is configured with a camera, the extracting of Y coordinate uses a Y coordinate of the user which is calculated with disparity information or depth information supplied from the camera.

21. The driving method of claim **15**, wherein the controlling of the barrier panel comprises:

extracting current position coordinates of the user from the images which are collected by the image collector, when a 3D image viewing mode;

comparing the current position coordinates with the view map to determine whether the current position coordinates correspond to an orthoscopic zone;

calculating an amount of change in a light transmitting area and light blocking area of the barrier panel which allows the current position coordinates correspond to the orthoscopic zone, by using the current position coordinates and the view map, when the current position coordinates do not correspond to the orthoscopic zone as a determined result;

generating a barrier control signal for controlling the barrier panel to transfer the barrier control signal to a barrier driver, according to the amount of change; and

controlling, by the barrier driver, the barrier panel according to the barrier control signal to switch the light transmitting area and the light blocking area by the amount of change.

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